



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

US Army TARDEC Ground Vehicle Mobility: Dynamics Modeling, Simulation, & Research

P. Jayakumar @ JPL 24 Oct 2011

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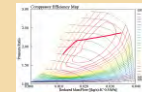
System Level Analysis



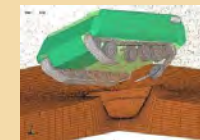
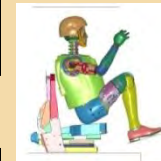
MRAP Example



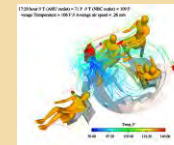
Mobility /
Automotive
Performance
Analysis



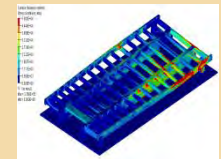
Blast / Crash
/ Ballistic
Analysis



Thermal /
Signature /
Aerodynamic
Analysis



Durability /
Reliability
Analysis



High Performance Computing Infrastructure

Life Cycle Modeling & Simulation Support

- Acquisition Support
 - Construct Virtual Technology Demonstrators
 - Develop automotive performance requirements
 - Write M&S content of the Request For Proposal
 - Participate in the Source Selection Evaluation Board
- Field System Support
 - Configuration changes
 - Waiver requests
 - Safe Use Range of Operation
 - Field failures

Research

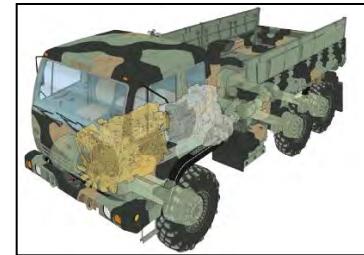
- Internal and External



ASV



MRAP



FMTV



FTTS



HMMWV



GCV



JLTV



M2



M915



Small Robot

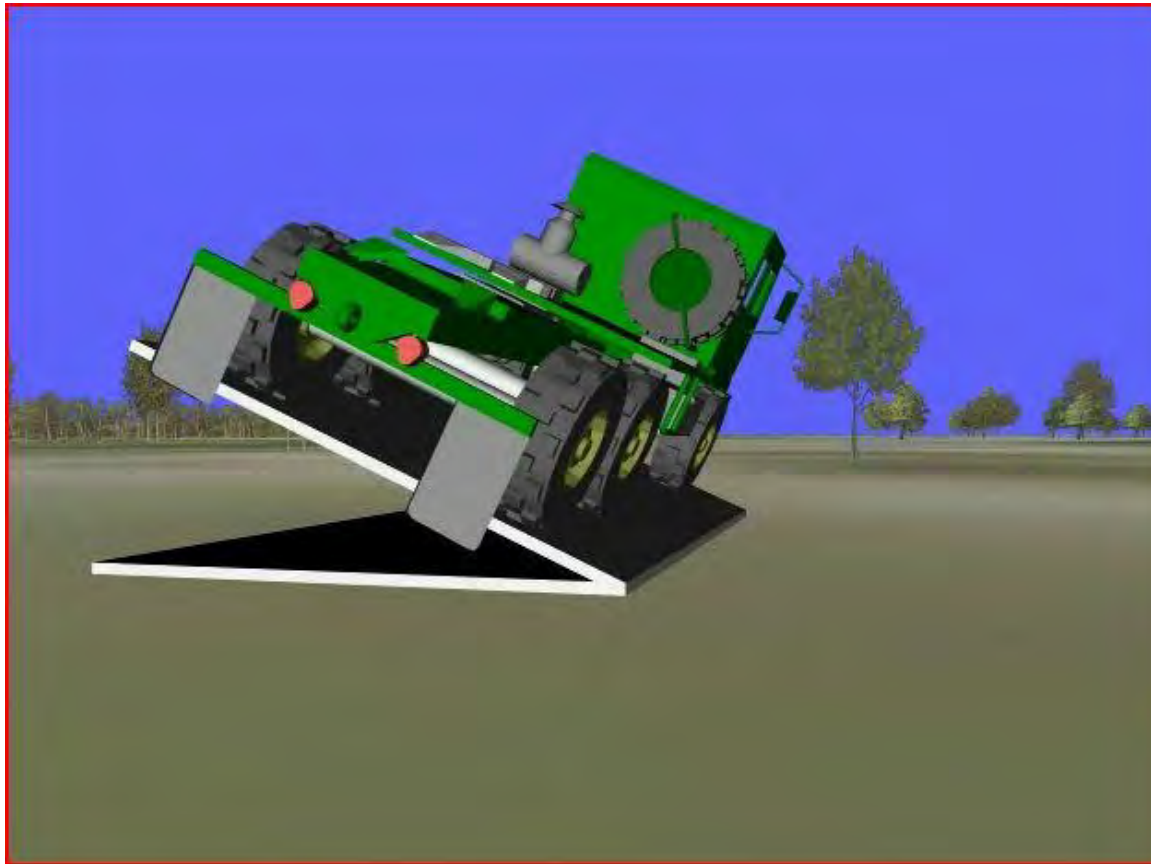


APD

- Vehicle stability
- Ride quality
- Durability
- Steerability
- Obstacle maneuverability
- Design sensitivities



Multi-Body Vehicle Dynamics

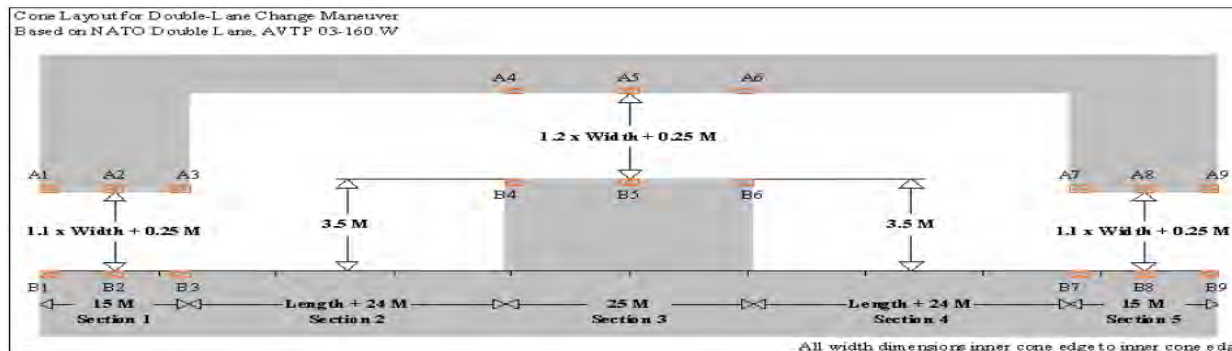


TiltTable-Standard.wmv

NATO Double Lane Change Stability



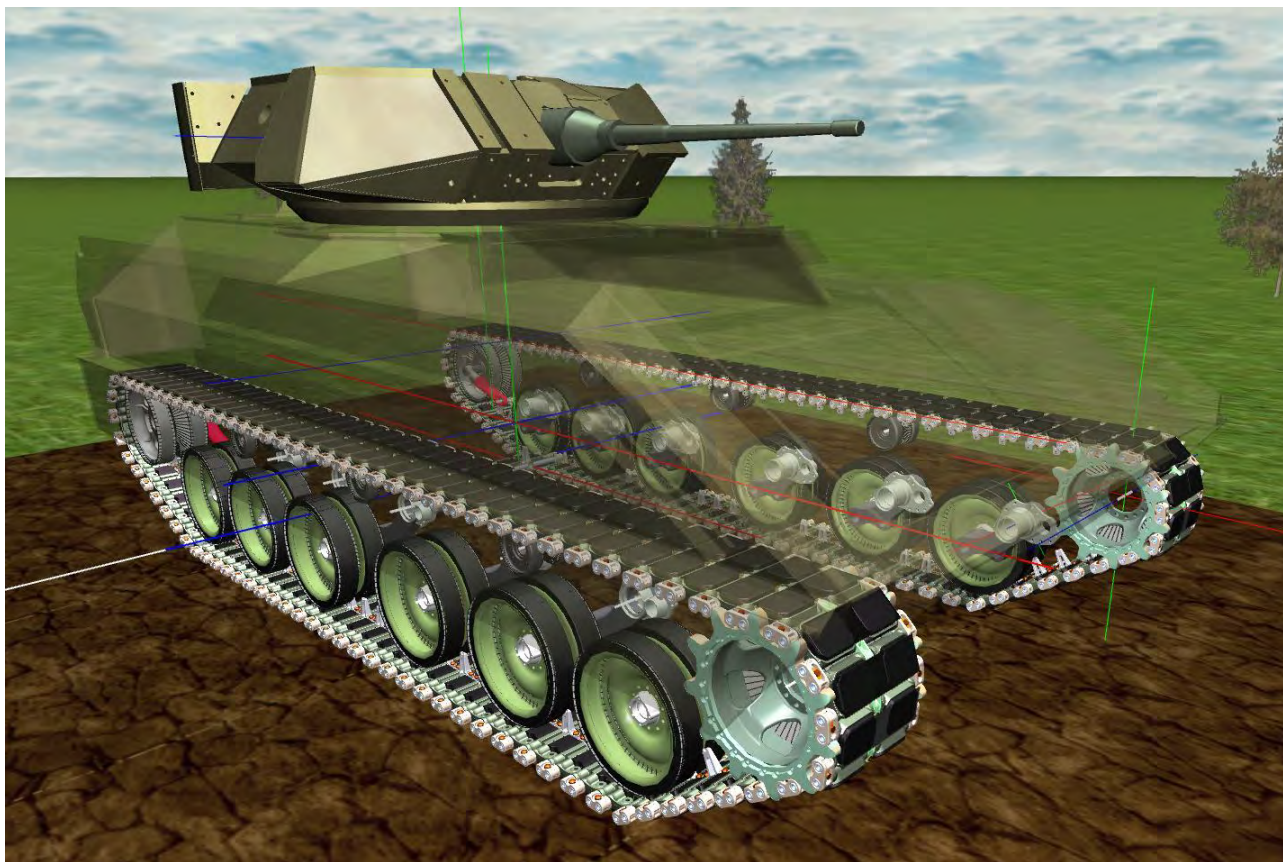
tan16700a-frontview.wmv





ah32big.wmv

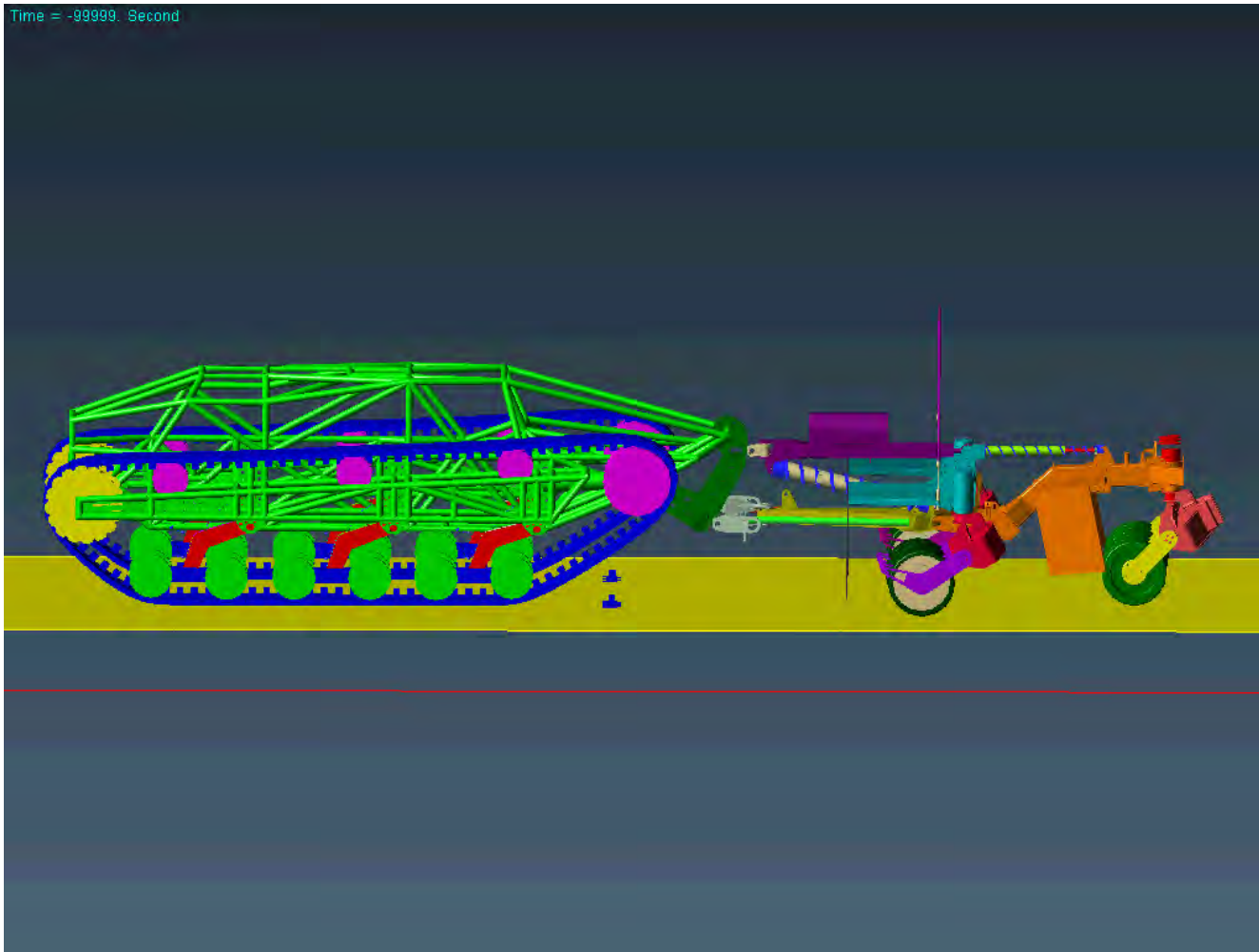
FE-Based Vehicle Dynamics



OPSEC_SegmentedTrack.avi



Brake-LSAC-40mph.wmv

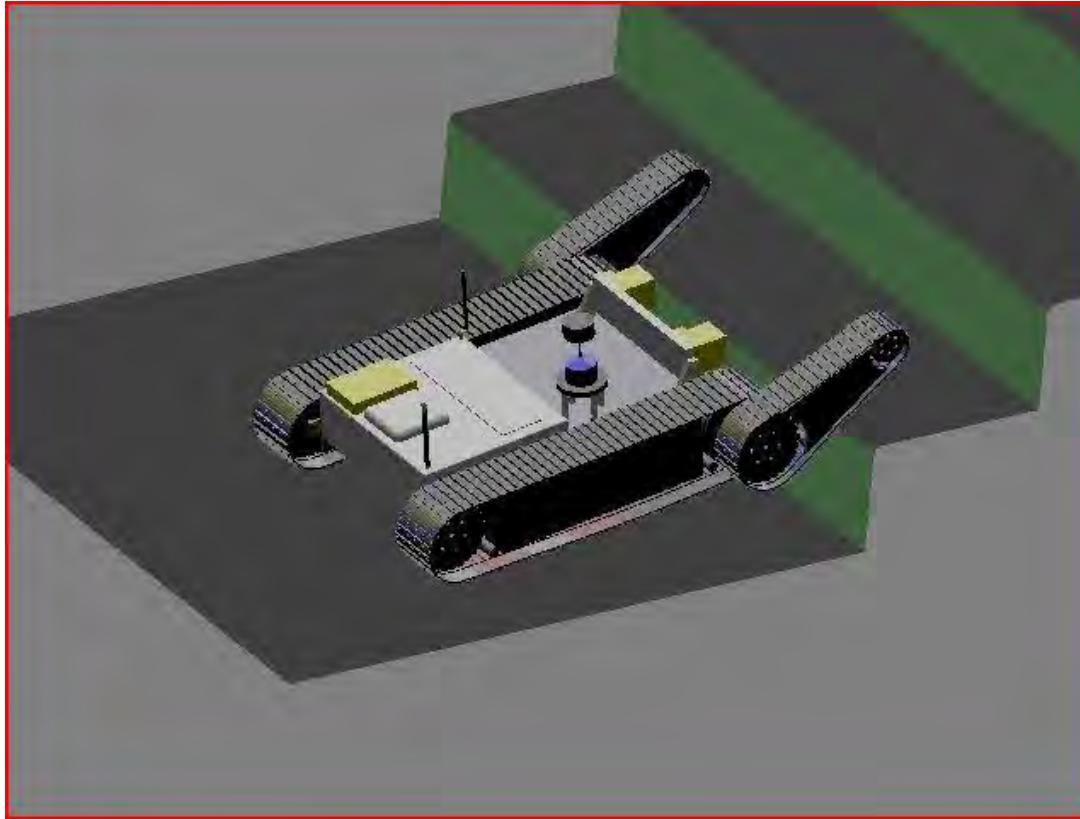


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Fluid-Structure Interaction



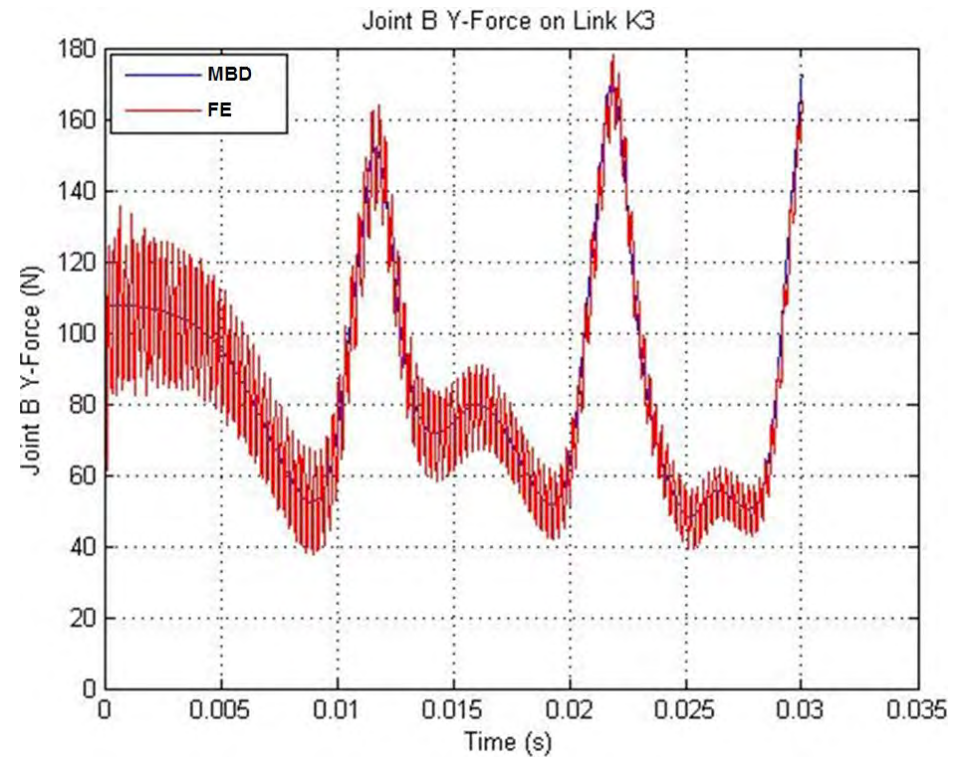
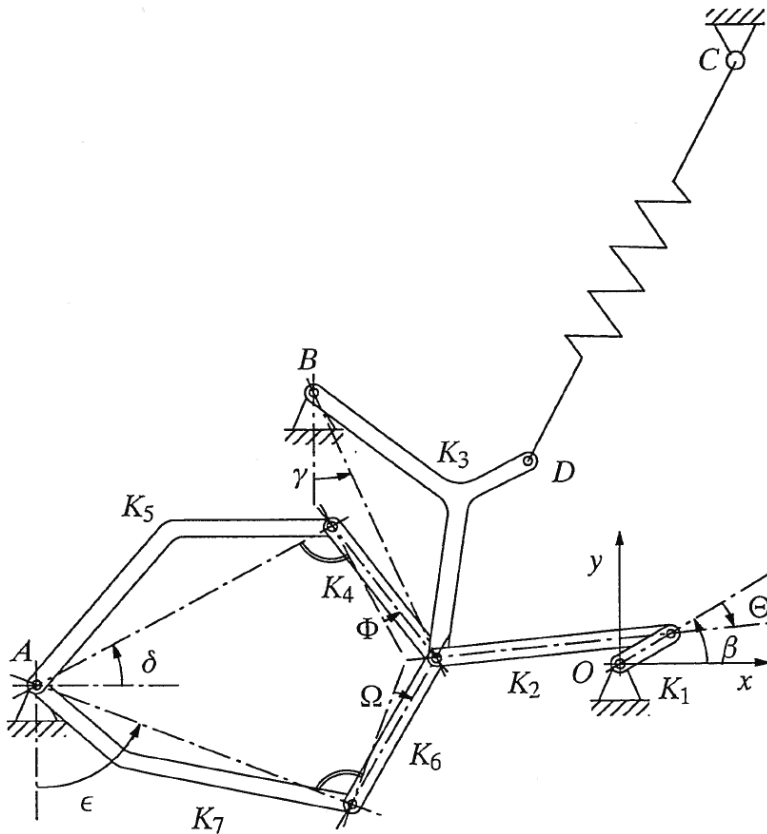
OPSEC_TankerTruck_LaneChange.avi



Urbie_final_rear.avi

$$d_i = \dot{x}_{p1_i} - \dot{x}_{p2_i}$$

Joint Force Comparison



OPSEC_MBD_Benchmark_Mechanism.avi

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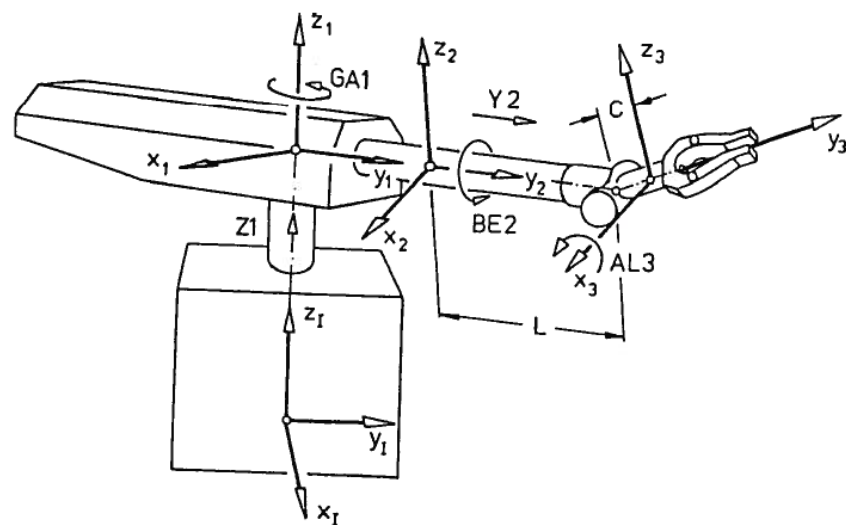
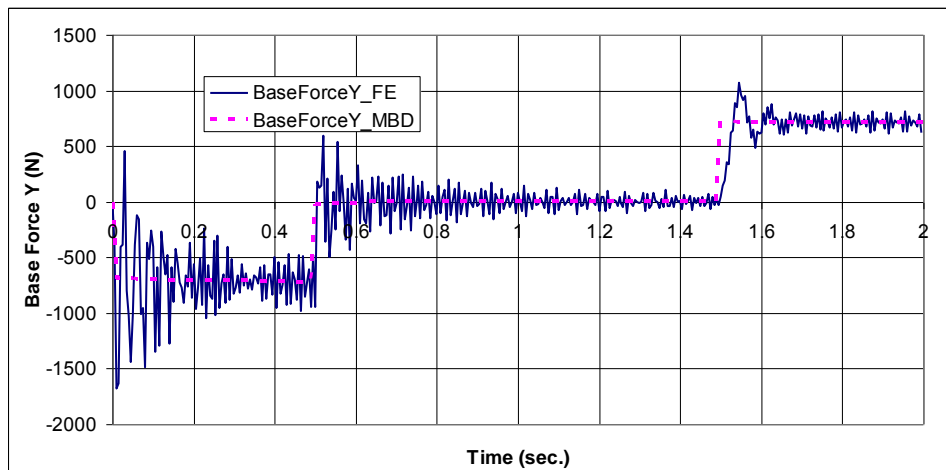
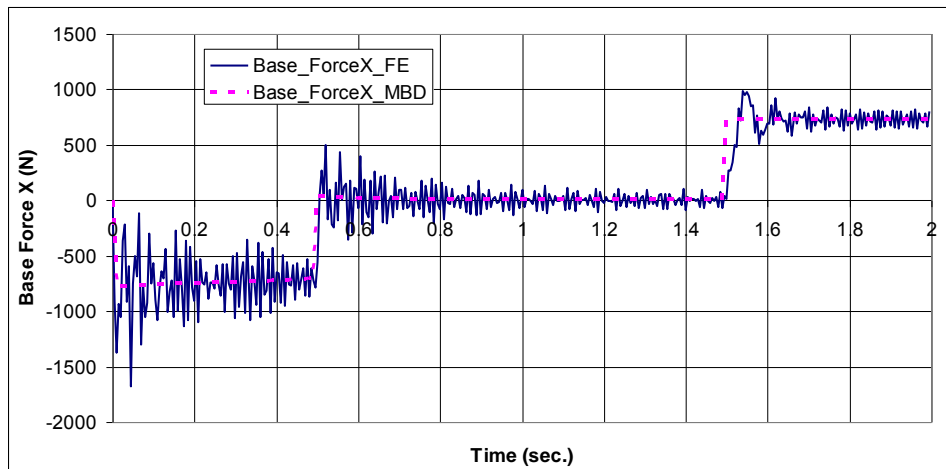
$$d_i = \dot{x}_{p1}'_i - \dot{x}_{p2}'_i$$



Finite-Element vs. MBD Solution



Manipulator Force Comparison



OPSEC_MBD_Benchmark_Robot.avi

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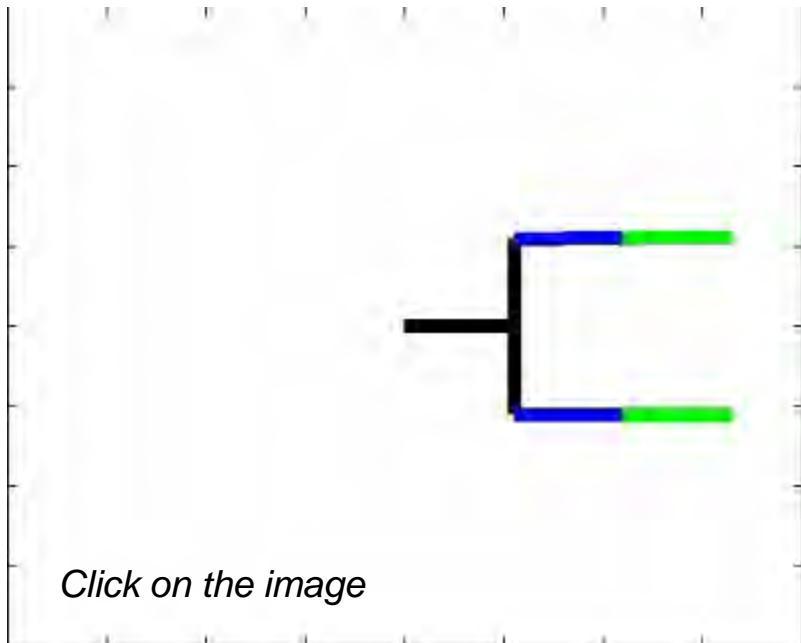
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M113



Click on the image

ANCF Finite Elements



Tracked Vehicle



$$\begin{bmatrix} \mathbf{M}_{rr} & \mathbf{M}_{rf} & \mathbf{0} & \mathbf{0} & \mathbf{C}_{q_r}^T \\ \mathbf{M}_{fr} & \mathbf{M}_{ff} & \mathbf{0} & \mathbf{0} & \mathbf{C}_{q_f}^T \\ \mathbf{0} & \mathbf{0} & \mathbf{M}_{aa} & \mathbf{0} & \mathbf{C}_{q_a}^T \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{C}_s^T \\ \mathbf{C}_{q_r} & \mathbf{C}_{q_f} & \mathbf{C}_{q_a} & \mathbf{C}_s & \mathbf{0} \end{bmatrix} \begin{bmatrix} \ddot{\mathbf{q}}_r \\ \ddot{\mathbf{q}}_f \\ \ddot{\mathbf{q}}_a \\ \ddot{\mathbf{s}} \\ \lambda \end{bmatrix} = \begin{bmatrix} \mathbf{Q}_r \\ \mathbf{Q}_f \\ \mathbf{Q}_a \\ \mathbf{0} \\ \mathbf{Q}_c \end{bmatrix}$$

Integrates

- rigid motion (r)
- flexible deformation (f)
- very flexible deformation (a)

